California Regional Water Quality Control Board
Santa Ana Region

RESOLUTION NO. 01-52
Orange County Sanitation District Ocean Monitoring Program
Phase II - Year 4 Strategic Process Studies



WHEREAS:

1. Board Order No, 98-5, waste discharge requirements for Orange County Sanitation District (OCSD), requires that OCSD annually propose strategic studies to address specific receiving water quality, discharge impact, or ocean process questions relating to the discharge. Order No. 98-5 further requires that OCSD obtain Regional Board and USEPA approval of the strategic studies proposed.

2. OCSD has submitted its proposal for Ocean Monitoring Program Phase II - Year 4 strategic process studies, which include:

    - Evaluation and application of Physical Oceanographic Model(s).
    - Moored current meter/thermistor.
    - Mapping of Spatial Current Patterns.
    - Correlation of Sediment Geochemistry to the Mass Emission Rates of Total Suspended Solids and Settleable Solids.
    - Long-Term Temporal and Spatial Trends in Trawl Fish Size-class and Length-Weight data.

3. Regional Board staff has conferred with OCSD and USEPA staff concerning OCSD's proposed Year 4 strategic process studies. Comments provided by Board and USEPA staffs have been incorporated into OCSD's Year 4 proposal.

4. Regional Board and USEPA staffs believe the proposed Year 4 studies are appropriate and within the intent of the Order No. 98-5 requirement that OCSD conduct strategic studies of the effects of its discharge on the marine environment.

THEREFORE, BE IT RESOLVED THAT:

The OCSD Ocean Monitoring Program Phase II – Year 4 strategic process studies proposal is approved.

I, Gerard J. Thibeault, Executive Officer, do hereby certify that the forgoing is full, true and correct copy of a resolution adopted by the California Regional Water Quality Control Board, Santa Ana Region, on April 19, 2001.

Gerard J. Thibeault
Executive Officer

California Regional Water Quality Control Board
Santa Ana Region

April 19, 2001

**ITEM:** 25

**SUBJECT:** Resolution No. 01-52: Orange County Sanitation District Year 4 Strategic Process Studies

**DISCUSSION:**

The Orange County Sanitation District (OCSD) operates a 120-inch ocean outfall which currently discharges up to 240 million gallons per day of treated wastewater into the Southern California Bight, 4.5 miles off the Huntington Beach shoreline at a depth of 200 feet. Board Order No. 98-5, NPDES No. CA 0110604, waste discharge requirements for OCSD, requires that the effects of this discharge on the marine environment must be evaluated. Monitoring and Reporting Program No. 98-5 requires OCSD to conduct ocean monitoring to assess the effects of the discharge in the vicinity of the outfall. Marine monitoring is also necessary if OCSD is to continue to discharge wastes to the ocean that have not received full secondary treatment. Subsection 301(h) of the Clean Water Act allows for a variance from the 100 percent secondary treatment requirement as long as a discharger can continue to demonstrate that there are no deleterious impacts to the marine environment from the discharge.

Effects of OCSD's discharge on the marine environment are monitored through a comprehensive ocean monitoring program conducted by OCSD. This program is structured to not only measure compliance with numeric and narrative standards of the California Ocean Plan, but also to monitor, measure and evaluate the marine communities that may be affected by the discharge. Benthic organisms, living in ocean sediments, and demersal fish, those that live near or on the ocean bottom, are included in this monitoring effort.

OCSD's ocean monitoring program is divided into three components; core monitoring, strategic process studies, and regional monitoring activities. Strategic Process Studies (SPS) represent the component of the ocean monitoring program that is purposely adaptive, and, therefore, not constrained by fixed measurement parameters that are repeated each sampling period. Instead, each year, study projects are proposed in order to address specific receiving water quality, discharge impact, or ocean process questions relating to the discharge. The scope of these study projects must first be developed and proposed by OCSD, and then, in accordance with Order No. 98-5, approved by the Regional Board and USEPA prior to implementation.

OCEAN MONITORING PROGRAM PHASE II – YEAR 3 SPS (Approved May 19, 2000)

Four strategic process study projects undertaken in Year 3 of OCSD's SPS program consisted of the continued development and/or application of physical oceanographic model(s) and complimentary field sampling aimed toward model verification and calibration. The modeling tools derived from these studies may be ultimately used to predict the movement of OCSD's waste plume. Field sampling methodologies included the use of a moored current meter/thermistor, a vessel mounted acoustic doppler current profiler (ADCP), and sediment traps located on the off shore sea bed shelf and within submarine canyons.

A fifth study supplemented the Year 1 SPS effluent characterization study, by conducting further effluent composition characterization and adding a toxicity evaluation. This last study provided data to assess and evaluate the effects of brine and backwash wastewater from the proposed Orange County Water District Ground Water Replenishment System groundwater recharge project on the final effluent composition and toxicity. The data will also be useful to model future impacts associated with different volumes and concentrations of brine.

OCEAN MONITORING PROGRAM PHASE II – YEAR 4 STUDIES PROPOSAL

OCSD has proposed five SPS projects to be undertaken in Year 4 of the SPS program. The primary objective the first four studies is to begin work on development of a mathematical model(s) that will describe the movement of the treated effluent after it is discharged into the coastal ocean, and begin to gather the information needed to validate and calibrate the model(s). These proposed studies incorporate and continue the physical oceanographic modeling work begun during Year 3. During the next year, the effort will focus on evaluation and integration of available models that meet OCSD's selection criteria. The goal of this SPS is to develop a model that is both predictive and diagnostic, and that can be used via the Internet. Several of these SPSs are a collaborative effort that includes private consultants, academia, and private and government research groups.

The last proposed study will cosist of statistical analyses on fish trawl data collected by OCSD between 1975 and 2000. Data will be evaluated for spatial and temporal trends, correlations, and gradient effects that would indicate differences in growth and development of fish collected at various monitoring stations in the vicinity of OCSD's outfall discharge.

A detailed description of the OCSD Ocean Monitoring Program Phase II Year 4 Proposed Strategic Process Studies, prepared by OCSD staff, is attached.

**RECOMMENDATION:**

Adopt Resolution No. 01-52 to approve OCSD's Ocean Monitoring Program Phase II – Year 4 Strategic Process Studies.

## 1. EVALUATION AND APPLICATION OF PHYSICAL OCEANOGRAPHIC MODELS

**Objective:** The primary objective is to provide the Orange County Sanitation District (District) and other interested groups with a model or models that will describe the transport and fate of the wastewater effluent after it is discharged into the coastal ocean receiving waters. The proposed Strategic Process Study is a continuation of work begun last year to evaluate existing physical oceanographic models applicable to the District's discharge. Over the next year the effort will focus on completing the evaluation and begin implementation of initial dilution, fate and transport and diagnostic models. If enough progress is made on these tasks, then three-dimensional modeling of the plume in near-real time may also be attempted.

**Benefits:** In the past the District has relied on empirical measurements to determine if we are protective of beneficial uses of the receiving water. However, oceanographic processes cover a variety of time and spatial scales, which presents very practical problems when trying to measure them in-situ. Calibrated and validated models offer a new tool to determine the temporal and spatial impacts of the District's wastewater plume. In addition, diagnostic modeling will allow "what-if" scenarios to be run by changing model inputs (e.g., amount and type of solids) that would reflect changes in effluent quality.

**Approach:** The District's has established a modeling workgroup consisting of consultants, academia and research agencies. This workgroup will evaluate, develop and apply the plume and coastal circulation models and will initially look at existing fate and transport and diagnostic models. Evaluation of three-dimensional modeling will occur in parallel but over a more extended time frame. To meet the above objectives, there are several conditions that a model needs to address. For example a model used to track particles, and the constituents associated with them, needs to be linked to prevailing oceanographic conditions to accurately represent where these particles are deposited. In addition, an effective model needs to account for (i.e., track) constituents with differing characteristics such as dissolved and particle-bound elements.

The model(s) chosen for use by the District will have the following characteristics:

- Nearfield: The ability to model or link to models of near-field flow following the first few minutes after release (i.e., initial dilution modeling).

- Farfield: Defined here as within the limits of the present receiving water monitoring stations and the inshore region and beaches.

- On and Near Bottom: Evaluation of settlement, accumulation, degradation, resuspension and transport, near-bottom bed-load transport.

- Surface: Capture wind influence to the neustonic or surficial water layers.

While integrating the above tracking fields a successful model will also need to address key oceanographic states such as the average seasonal conditions (e.g., winter, spring, summer and fall) and their associated oceanographic conditions (e.g., stratified, unstratified or weakly stratified) as well as specific oceanographic conditions associated with currents (e.g., upcoast, downcoast, minimum and maximum currents) upwelling and surface tides. To be used in a diagnostic mode a model must handle modifications or changes to the physical, chemical, and biological components used as input into the model. These would include particle densities that would effect settling and floating characteristics, flow and concentration of effluent constituents. Finally, for use on the Web, the model will need to use telemetered data from a current meter/thermistor mooring and provide real-time or near real-time depiction of where plume is and show concentration isopleths per depth layer or in 3-D. The model must also be able to nowcast or hindcast on limited new input data in the future (e.g., single current meter mooring).

Model selection criteria will be established beforehand so that inappropriate models and modeling techniques can be screened out with a minimum expenditure of effort, time, and cost. The type of criteria used will include conditions that must be met and those that preferably should be met. In addition, to be considered, a model would need to have a demonstrated record of performance for similar applications, adequate user documentation and details on its theoretical basis. Other important model selection criteria will include the amount of vetting or peer review it has undergone, whether it is publicly available and non-proprietary and how it is supported and maintained.

**Project Duration:** This is an on-going multiple-year SPS. Table 1-1 contains the proposed schedule and milestones.

**Deliverables:** The District anticipates completing the following products:

- A model that will describe the transport of different effluent constituents so that the fates of these constituents over specified time periods reflect distributions that have been observed under specified oceanographic conditions (e.g., calibration and validation).

- A diagnostic model as a tool to predict or forecast potential future effluent changes

- Identify the issues related to putting a three-dimensional model output on a web site to provide resource or regulatory agency personnel with real-time or near real-time depictions of where various components of the plume are distributed.

**Collaborators:** The District has an established working group to develop and/or adapt models to wastewater plumes that includes private consultants, academia and research groups. The District will also work to involve various federal and state agencies (e.g., US Geological Survey, State Water Resources Board).

Table 1-1. Scheduling, products and milestones

| Time Frame | Product/Milestone |
|---|---|
| Within 6 months | (1) Identify the type of data that will be needed for model components (e.g., currents).<br>(2) Establish criteria screen for models, sub-models and data needs.<br>(3) Identify potential models and submodels |
| Within 1 year | (1) Model review and selection.<br>(2) Data acquisition. |
| Within 2 years | (1) Install and adapt software.<br>(2) Scale and calibrate model.<br>(3) Run selected scenarios (e.g., non-stratified versus stratified).<br>(4) Validate and assess accuracy.<br>(5) Develop outputs.<br>(6) Finalize model. |
| Within 3 years | (1) Program for real-time conditions and begin nowcasting.<br>(2) Develop documentation.<br>(3) Establish training |

## 2. MOORED CURRENT METER/THERMISTOR

**Objective:** To provide continuous measurements of oceanographic conditions to characterize prevailing physical processes, mainly temperature and currents, that effect plume fate and transport. A secondary objective is to provide data input into physical oceanographic models.

**Benefits:** The measurement of currents provides critical information on where the subsurface plume is. This data will be used in evaluating receiving water monitoring results and determining compliance with Ocean Plan criteria and NPDES permit conditions. Without this data, modeling particle transport and fate cannot be accomplished.

**Approach:** Moored instruments (current meters and thermistors) record speed and direction and water temperatures at different water depths. The data is stored internally within each instrument. A single current meter/thermistor mooring will be deployed and maintained in the vicinity of the District's outfall in 60 m of water. The final location and mooring configuration are presently being developed co-operatively with the US

Geological Survey. However, the following types of instruments will be deployed on this mooring: (1) Acoustic Doppler Current Profiler to obtain current measurements throughout the water column; (2) Temperature/Conductivity sensors, (3) pressure sensor to measure surface wave height and direction; and (4) meteorologic station measuring air temperature and wind speed and direction. The mooring would be serviced and the data retrieved on a quarterly basis. In addition, the use of telemetry will allow sending selected data to a shore station to provide real-time monitoring of coastal conditions.

**Project Duration:** It is expected that this mooring will become a long-term monitoring site to support routine receiving water monitoring and in proposed plume modeling efforts.

**Deliverables:** The moored instrumentation produces time series data with sampling intervals typically being less than one hour. These data will be analyzed and presented in standard formats including time series plots of current, wind and surface wave components, water and air temperature, and stick plots of current, wind and wave vectors. In addition, a co-operative project is being developed with US Geological Survey to put this data onto a web site for public use. Data obtained from this project will also be used in the evaluation of plume models.

**Collaborators:** Presently the District is working with US Geological Survey to design and deploy the proposed mooring. In addition, US Geological Survey has indicated that they would be available to analyze the data. It is also expected that the District will also use oceanographers from private consulting firms and local universities (e.g., University of Southern California and University of California, Los Angeles).

### 3. MAPPING OF SPATIAL CURRENT PATTERNS

**Objective:** The primary objective of this study is to obtain a series of spatial representations of currents by measuring current velocities, direction and duration (e.g., spatial coherency) along a set of cross-shelf transects. A secondary objective is to provide data to help calibrate and validate the modeling of plume dynamics.

**Benefits:** Measuring the spatial variability of currents, in conjunction with current data from a fixed point (see #2 above) will help in calibrating and validating physical oceanographic model(s) (see #1 above). This is especially true as the currents begin to interact with the shoreline (e.g., boundary condition). In addition, this information will lead to a better understanding of the short time-scale variability seen in currents.

**Approach:** The District has an established field data acquisition program. A vessel-mounted acoustic Doppler current profiler (ADCP) will be deployed along transects within the District's study area, including the area where the moored current meter is deployed (Figure 3-1). Each cruise provides a near simultaneous "snapshot" of currents

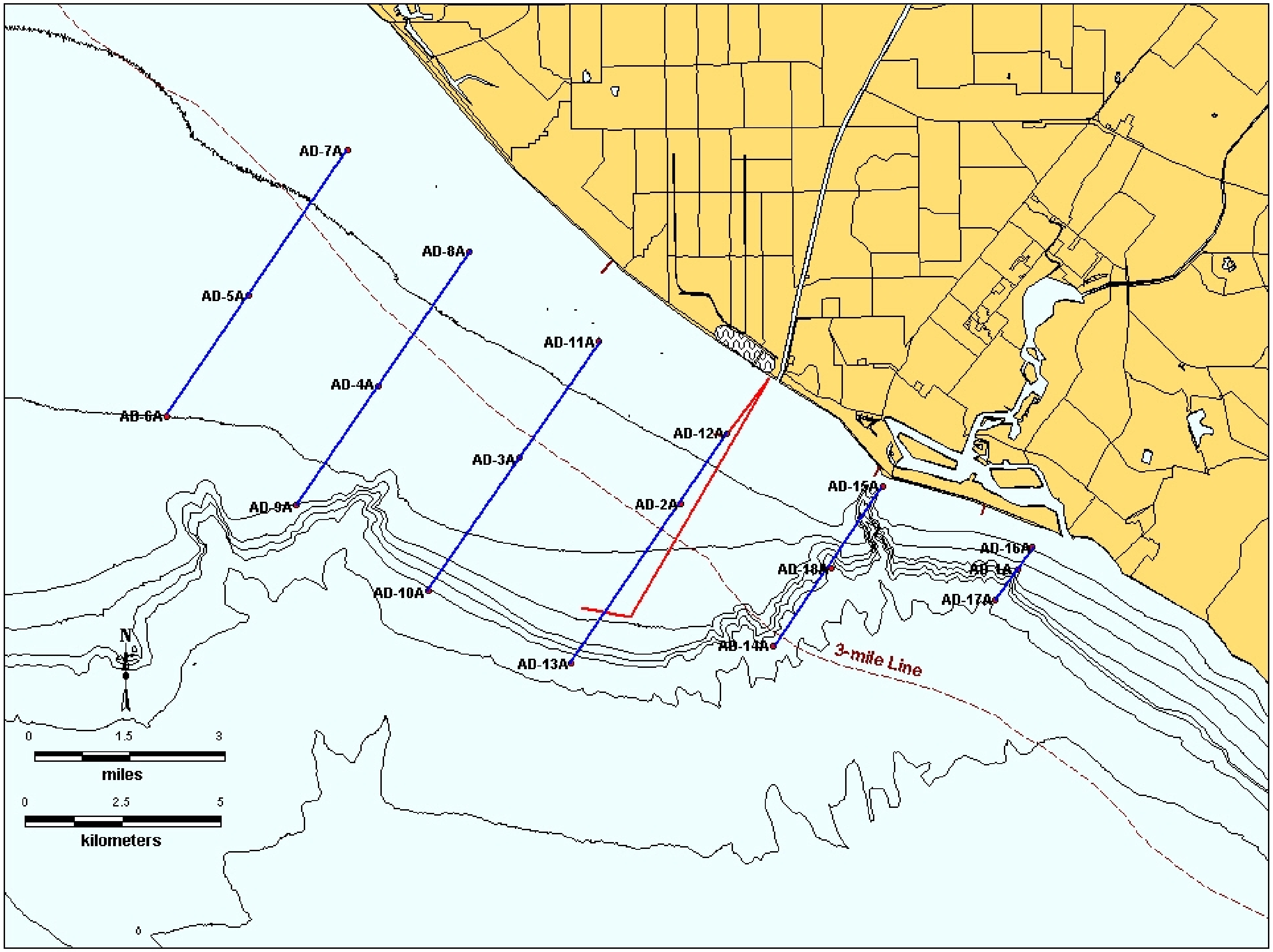


**Figure 3-1. Cross-shelf transects for towed ADCP survey. Orange County Sanitation District.**

within the study area. Data acquisition will consist primarily of scheduled monthly surveys. When possible we will sample during event-based conditions in order to measure the influence of periodic (e.g., surface tides) and non-periodic (e.g., Santa Ana Winds) events. In addition, if needed, additional surveys will be done to collect data to for model evaluation, calibration and/or validation.

**Project duration:** One year.

**Deliverables:** To achieve the goal of spatially characterizing the currents in the study area, visualizations of the current field snapshots will be developed and presented in combination with statistical analysis. A written **s**ummary report covering the entire year will be prepared. In addition, this data will be used as both input into models and as a way to evaluate the effectiveness of those models.

**Collaborators:** None anticipated. An outside group may be needed to review and interpret current meter data.

### 4. CORRELATION OF SEDIMENT GEOCHEMISTRY TO THE MASS EMISSION RATES OF TOTAL SUSPENDED SOLIDS AND SETTABLE SOLIDS

**Objectives:** The objective of this strategic process study is to address the following questions: (1) Is the ecosystem being protected?; (2) What is the spatial extent of effects on the sediment geochemistry from the discharge of solids from the District's outfall?; and (3) Is there a correlation between the mass emission rates of solids from the District's outfall to sediment geochemistry parameters at the District's benthic monitoring stations?, and If so, is there a gradient of effects with increasing distance from the outfall?

**Benefits:** Previously, the Orange County Sanitation District (District) looked at sediment geochemistry relative to spatial and temporal trends, final effluent discharge rates, and the correlation of decreases in certain effluent metals to decreases in sediment metals concentrations. The long-term correlation of the mass emission rates of solids (Total Suspended Solids [TSS] and Settable Solids [SS]) to sediment geochemistry parameters has not been investigated. In addition with the change in treatment of the past twenty-five years, the characteristics of solids has changed to such an extent that TSS may no longer be the most relevant measure of impact to the ocean bottom and its associated biologic communities. This project will provide a measure of the spatial effects of solids discharge and the location of effects for each particle type.

**Approach:** This study will be based on data from the District's long-term ocean monitoring (e.g., sediment geochemistry parameters) and effluent (e.g., solids mass emission rates) databases. The quarterly 60-m benthic stations will be the focus of the study. The sediment geochemistry and physical parameters tested will include trace organics (total DDT, total PCB, and total PAH), a suite of metals (arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc), sediment organic content (total organic carbon and sulfides), and grain size (percent fines and median phi). The solids discharge parameters will include the mass emission rates of total suspended solids and settable solids.

Statistical analyses will include Pearson Product Moment Correlation to test for correlations of the solids emissions to sediment geochemistry parameters, linear regression techniques for temporal trend analysis, and analysis of variance techniques (e.g., single-factor ANOVA and RM ANOVA) and multivariate techniques (e.g., PCA) to determine similarities and/or differences among stations in sediment geochemistry parameters.

A pilot study was conducted using sediment geochemistry data collected from outfall station 0 and upcoast reference Station Control 1 from 1985-1997. This data was tested for statistical correlation to the mass emission rate of TSS from the District's outfall. The list of sediment physical and chemical parameters tested and the results of the correlation analysis are presented in Table 4-1.

Table 1-2. Sediment geochemistry parameters tested and the results of correlation Analysis (r-value) of the parameters to the Mass Emission Rate of Total Suspended Solids. Bolded correlation coefficient values are significant at $0.532_{\forall=0.05,\ 2\text{-tailed},\ 12df}$.

| Characteristic | Station 0 | Station Control 1 |
|---|---|---|
| TOC | 0.262 | **0.538** |
| TDDT | 0.455 | **0.580** |
| tPAH | 0.399 | -0.477 |
| tPCB | **0.532** | 0.278 |
| Arsenic | **0.532** | -0.152 |
| Berylium | 0.479 | 0.422 |
| Cadmium | 0.507 | 0.444 |
| Chromium | **0.661** | -0.444 |
| Copper | **0.640** | -0.217 |
| Lead | **0.566** | 0.482 |
| Mercury | 0.019 | -0.113 |
| Nickel | **0.639** | **0.617** |
| Selenium | 0.476 | 0.334 |
| Silver | 0.215 | 0.074 |
| Zinc | **0.639** | **0.551** |

The results of the pilot study showed that the mass emission rate of TSS was significantly correlated to total PCB, arsenic, chromium, copper, lead, nickel, and zinc at Station 0 and to total organic carbon (TOC), total DDT, nickel, and zinc at reference Station Control 1 (Table 4-1). All correlations were positive indicating that an increase in mass emission rate of TSS produced an increase in sediment chemical concentration. Station Control 1 is the upcoast reference site, yet it appears it may be influenced by solids emission from the District's outfall as evidenced by the correlation between TSS and TOC. Interestingly there was no correlation between silver, which is commonly used as an effluent tracer in sediments and TSS at station 0. However, since no intermediate stations were tested, it is not known if there is a gradient of effects, which would better indicate an outfall effect.

**Project Duration:** This study will be conducted over a one-year period.

**Deliverables:** A report will be written for inclusion in the Ocean Monitoring Annual Report and a manuscript will be prepared for submission to a peer-reviewed journal and/or a technical/scientific conference.

**Collaborators:** None.

### 5. LONG-TERM TEMPORAL AND SPATIAL TRENDS IN TRAWL FISH SIZE-CLASS AND LENGTH-WEIGHT DATA.

**Objectives:** The objective of this strategic process study is to address the following questions: (1) Is the ecosystem being protected?; (2) Are there spatial trends in the size-class distributions or robustness of demersal fish relative to the District's outfall?, If so, is there a gradient of effects with increasing distance from the outfall?; and (3) Are there long-term temporal trends in the size-class distributions or robustness of demersal fish collected within the District's study area? If so, do trends correlate to oceanographic conditions?

**Benefits:** The current analysis of District's trawl fish data measures potential community-level effects only (e.g., diversity measures). The long-term analysis of demersal fish size-class data relative to the outfall will provide a measure of potential outfall effects on fish growth, a sub-community level effect and a potentially more sensitive measure of effects. Similarly, fish robustness or plumpness is a measure of fish condition at the individual fish level with a potential for additional effect sensitivity. This study will also help to determine the efficacy of continuing to weigh and measure individual fish as opposed to measuring individual fish and batch weighing by species.

**Approach:** This study will be based on trawl demersal fish data from the District's long-term ocean monitoring database covering the years 1975 through 2000. The semi-annual 60-m stations will be the focus of the study. Data from other depth strata may be included. The primary individual species to be focused on in this study are the Pacific sanddab (*Citharichthys sordidus*), yellowchin sculpin (*Icelinus quadriseriatus*), and California tonguefish (*Symphurus atricauda*). The species selection criteria were frequency of occurrence in trawl surveys at the 60-m stations (particularly at outfall Station T1 and reference Stations T3 and T11), total abundance, potential for site fidelity, and mode of feeding. Other considerations include comparability to other data sets (e.g., regional monitoring surveys) and species of economic or ecological interest. Additional species that may be incorporated into the study include, but is not limited to, hornyhead turbot (*Pleuronichthys verticalis*), California scorpionfish (*Scorpaena guttata*), and Dover sole (*Microstomus pacificus*).

Size-class and biomass data for target species will be examined, measures of central tendency and dispersion calculated and then tested statistically for differences among sampling stations and years. The Index of Condition, a measure of fish robustness that is used as an indicator of environmental conditions, will be calculated for individual fish and then tested statistically for differences among sampling stations and years. The Index of Condition is calculated as follows:

$$K = (W \times 10^5) / L^3$$

Where, $K$ = Index of Condition
$W$ = weight in grams
$L$ = length in millimeters.

If significant differences among stations are found with analysis of variance (ANOVA) techniques, correlation's to the District's mass emission rates of total suspended solids (TSS) and settleable solids (SS) will be conducted. If changes through time are found and results indicate similar changes at outfall and reference stations, correlations to oceanographic conditions (e.g., water temperature) will be tested. Statistical analyses will include Pearson Product Moment Correlation, linear regression techniques for temporal trend analysis, analysis of variance techniques (e.g., single-factor ANOVA and RM ANOVA), and multivariate techniques (e.g., PCA) to determine similarities and/or differences among stations.

A pilot study was done using trawl data collected on the Pacific sanddab from 1985-2000. Mean size class and mean biomass were calculated for outfall Station T1 and upcoast reference Station T11 and downcoast reference Station T3. Single-factor ANOVA was used to test for differences among stations. When a difference was found, the Tukey Multiple Comparison Test was used to identify which stations differed.

The results of the pilot study showed that there was a significant difference among stations in mean size class ($P < 0.001$). Station T1 and T3 did not differ, while both differed from Station T11. The same results were found for both Index of Condition ($P < 0.001$) and mean biomass ($P < 0.001$) (Table 5-1). No significant correlations were found for any parameter to the mass emission rates of TSS or SS.

These results show a consistent difference in secondary production characteristics in Pacific sanddabs between outfall station T1 and upcoast reference station T11. While no correlations of sanddab size and health parameters were seen to effluent solids emission rates at any station tested, further investigation is warranted into whether this pattern extends to other fish species within the District's study area and, if so, to identify potential causes (i.e., mass emission rates of effluent solids).

Table 5-1. Results of ANOVA/Tukey and Kruskal-Wallis/Nemenyi Analyses of Mean Size Class, Mean Biomass, and Mean Index of Condition for Pacific Sanddab (*Citharichthys sordidus*) Collected in District's Trawls: 1985-2000.

| Parameter Tested | Data Transformation | P-Value | Mean Value (Untransformed) Multiple Comparison Test Station Separation |
|---|---|---|---|
| Mean Size Class (cm) | Rank | < 0.001 | 9.3 9.2 7.6<br>T3 T1 T11 |
| Mean Biomass (g) | nt | < 0.001 | 14.5 12.8 6.3<br>T3 T1 T11 |
| Mean Index of Condition* | nt | < 0.001 | 1.52 1.47 1.35<br>T3 T1 T11 |

*Data unable to be normalized by transformation. Kruskal-Wallis non-parametric test and Nemenyi Multiple Comparison Test performed in place of single-factor ANOVA and Tukey Multiple Comparison Test

**Project Duration:** This study will be conducted over a one-year period.

**Deliverables:** A report will be written for inclusion in the Ocean Monitoring Annual Report and a manuscript will be prepared for submission to a peer-reviewed journal and/or a technical/scientific conference.

**Collaborators:** None.